

3.1: Introduction to Seasonal Pool Fauna

Seasonal pools provide important habitats for invertebrates, amphibians, reptiles, birds, and mammals. Amphibians are among the most conspicuous visitors to seasonal pools, especially between late winter and summer. During the breeding season, congresses of salamanders and choruses of frogs provide visual and auditory notice of their presence. For a period of time after adults breed and return to their terrestrial habitat, egg masses and then larvae remain in the pool.

The hydroperiod of a seasonal pool plays a significant role in determining the community of animals it will support (Wiggins et al., 1980; Semlitsch et al., 1996; Skelly, 1997; Morey, 1998; Semlitsch, 2003). A hydroperiod shorter than one month will not support the reproduction of most seasonal pool-breeding amphibians. Conversely, efficient predators of seasonal pool-dependent species, such as aquatic salamanders, bullfrogs, and large-sized predatory invertebrates, may potentially colonize pools that have longer hydroperiods (Thompson et al., 1980; Wilbur, 1980; Semlitsch et al., 1996; Skelly, 1997; Semlitsch, 2003). A given seasonal pool may be suitable habitat for only a subset of seasonal pool-dependent species (Zedler, 2003). Hydroperiod affects invertebrate community composition, abundance, biomass, and biological production (Leeper and Taylor, 1998). As characteristics of pools change over time (e.g., succession of vegetation, lengthening or shortening of hydroperiod), the amphibian and invertebrate communities' species compositions may shift.

This section introduces the faunal communities of seasonal pools. The Field Guide found on pages 37-68 provides more detailed information on these species. It contains descriptions of the physical characteristics, behavior, phenology, reproductive biology, and geographic range of these species and provides photographs to aid in their identification.

Note: This section and the Field Guide primarily focus on the faunal communities of annual pools. Many of these animals also successfully inhabit or breed in other seasonal pools (i.e., ephemeral pools or semipermanent pools). Additional research is needed to adequately describe the faunal communities of ephemeral pools and semipermanent pools.

3.2: Indicator and Facultative Species

Indicator species rely on seasonal pools as essential habitat for a portion of their life cycles. These species, sometimes also referred to as obligate species, are dependent upon seasonal pools for their continued existence (Box 3-1). Indicator species have evolved to exploit seasonal pools: they respond rapidly to the filling of the pool and their populations persist through dry periods, due to structural, behavioral, or physiological adaptations (Wiggins et al., 1980; Williams, 1987; Zedler, 2003). Indicator species of annual pools in the mid-Atlantic region include nine species of amphibians (seven species of mole salamanders, the wood frog, and the eastern spadefoot) (Figure 3-1) and a crustacean group (the fairy shrimp). As research on the natural history of amphibians and invertebrates of seasonal pools continues, there may be additional species that are determined to be indicators.

Some of the amphibian indicator species may sometimes breed in other pool types, such as small permanent ponds, road-rut pools, or roadside ditches (Petranka, 1998; Hulse et al., 2001; DiMauro and Hunter, 2002). However, these alternate breeding sites may result in reduced survival of eggs and larvae. Roadside ditches and other anthropogenic pools may dry too quickly to allow species of amphibians to reach metamorphosis (DiMauro and Hunter, 2002). More permanent pools may harbor fish and other vertebrate predators that prey heavily on developing invertebrates and amphibians (Ireland, 1989). Seasonal pools represent



the most desirable breeding habitat for these indicator species because of the higher likelihood of successful reproduction.

There are also numerous facultative species that use seasonal pools – the more common or significant facultative species are included in this section and the Field Guide. Facultative species use seasonal pools for foraging, shelter, water, or breeding, although they can successfully breed in other habitat types (Box 3-1). Facultative species of seasonal pools in the mid-Atlantic region include many aquatic invertebrates, amphibians, turtles, snakes, birds, and mammals.

Box 3-1

Indicator vs. facultative species in seasonal pools

Indicator species REQUIRE seasonal pools for optimal breeding conditions.

Facultative species USE seasonal pools for obtaining food, water, temporary cover, or breeding, although they can also successfully breed in other habitats.



Common Name	Scientific Name	STATES					
		Del.	Md.	N.J.	Pa.	Va.	W. Va.
Spotted Salamander	<i>Ambystoma maculatum</i>	Northern 1/2	Entire except southern Eastern Shore	Northern 3/4	Entire	Entire	Entire
Marbled Salamander	<i>Ambystoma opacum</i>	Entire ¹	Entire except far western	Entire	Scattered distribution southern & eastern 1/2	Mainly eastern & southeastern	Mainly eastern, southeastern, & western
Eastern Tiger Salamander	<i>Ambystoma t. tigrinum</i>	Entire ¹	Eastern Shore & southern tip ²	Southern 1/3	1 county ³	Southeastern & 1 county in Shenandoah Valley	X
Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	X	Western 1/3	Northern 1/3	Scattered distribution ⁴	Western (Blue Ridge, Valley & Ridge, Allegheny)	Scattered distribution (mainly along Allegheny)
Blue-Spotted Salamander	<i>Ambystoma laterale</i>	X	X	Northern 1/3	X	X	X
Mabee's Salamander	<i>Ambystoma mabeei</i>	X	X	X	X	Southeastern	X
Mole Salamander	<i>Ambystoma talpoideum</i>	X	X	X	X	Isolated south-central	X
Wood Frog	<i>Rana sylvatica</i>	Entire	Entire	Entire	Entire	Entire except southeastern	Entire though scattered distribution
Eastern Spadefoot	<i>Scaphiopus holbrookii</i>	Entire ¹	Southern & eastern; Eastern Shore	Entire, though scattered distribution in northern 1/2	Parts of eastern & south-central	Eastern & southeastern; scattered western distribution	Isolated, scattered distribution

Figure 3-1. Distribution of amphibian indicator species in mid-Atlantic seasonal pools.* Cells marked with “X” indicate that the species is not currently present in that state. Fractions indicate the approximate proportion of the state in which the species occurs.

¹Not found north of Fall Line in extreme northern Del. (White and White, 2002); ²Extirpated from Charles County, Md.; ³Record from Chester County is historical; they are likely extirpated from Pa. (Hulse et al., 2001); ⁴Hybrid populations of Jefferson and blue-spotted salamanders may occur in several locations in Pa., but genetic analyses need to be conducted to clarify this issue (Hulse et al., 2001).

* Distribution information for the mid-Atlantic states was primarily obtained from the ARMI National Atlas for Amphibian Distributions (<http://www.pwrc.usgs.gov/armiatlas/>) and Petranks (1998). Information on ranges in specific states was supplemented with Harris (1975) and White and White (2002) for Del. and Md., Schwartz and Golden (2002) for N.J., Hulse et al. (2001) for Pa., Martof et al. (1980) and Mitchell and Reay (1999) for Va., and Green and Pauley (1987) for W. Va.



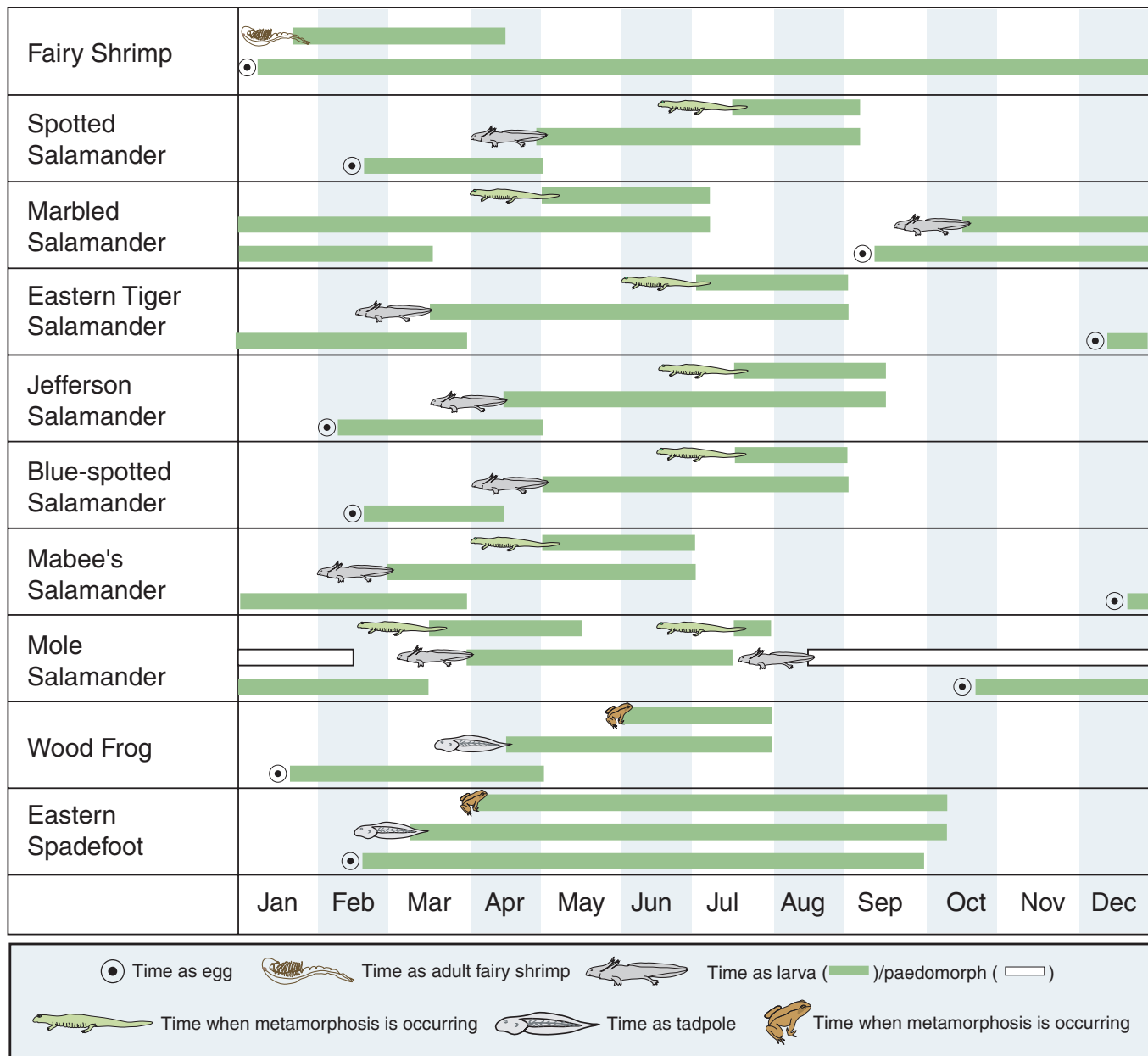


Figure 3-2. Breeding phenologies of seasonal pool indicator species.* This chart displays the life stages of indicator species in the mid-Atlantic region according to time of year. The combined length of the illustration and the green/white bar represents: the approximate time duration for when amphibian eggs and larvae may be present, when eggs and adult fairy shrimp may be found, and when amphibian metamorphosis may occur.

* References include Bishop (1941), Green and Pauley (1987), Tyning (1990), Petranksa (1998), Hulse et al. (2001), Smith (2001), Schwartz and Golden (2002), and White and White (2002).



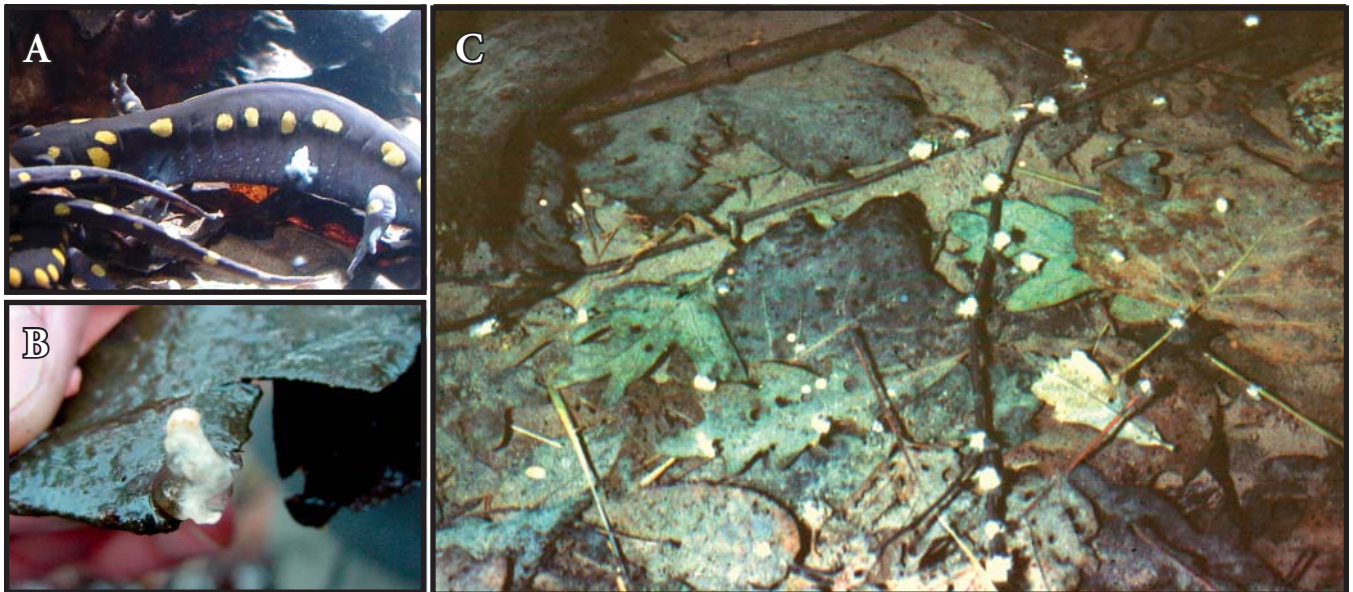
3.3: Salamanders in Seasonal Pools

Salamanders are four-limbed amphibians with long tails and smooth skin that live in moist or wet environments to avoid desiccation. In mid-Atlantic seasonal pools, there are seven species of salamanders that are indicators (Fig. 3-1, 3-2). These salamanders are in the mole salamander family, Ambystomatidae. The mole salamander family derives its common name from the terrestrial behavior of adults, who spend much of their lifetimes underground, often in shrew or other small mammal burrows, or beneath debris. These salamanders emerge above ground primarily during the breeding season when they migrate to and breed in seasonal pools. Mole salamanders tend to be very faithful to their breeding sites, often returning each year (although individuals may skip years) to the same pools following the same migration paths (Box 2-3; Shoop, 1968; Stenhouse, 1985; Scott, 1994; Windmiller, 1996).

On land, adult salamanders play important roles in forest ecology as major predators of forest floor

arthropods and as prey to reptiles, birds, and mammals (Windmiller, 1996). In seasonal pools, smaller-sized ambystomatid salamander larvae are a food source for backswimmers, predaceous diving beetles, and other predators; larger-sized (later-development stage) larvae may function as top predators of aquatic invertebrates and other developing amphibians, including conspecifics. Salamanders may exert a controlling effect on mosquito populations; mosquito larvae density was 98% lower in wetlands with ambystomatid salamanders compared to wetlands with no salamanders (Brodman et al., 2003).

Ambystomatid salamanders have internal fertilization with a sperm transfer mechanism using spermatophores (Plate 3-1). Males deposit spermatophores (sperm capsules atop conical gelatinous bases) on pool bottoms, vegetation, rocks, or land. Males court individually or in groups, known as congresses, by performing underwater courtship dances for the females (Tyning, 1990).



Photos: (A, B) Michael Male, (C) Steven M. Roble

Plate 3-1. Spermatophores of spotted salamanders. (A) A spermatophore is shown next to an underwater salamander and (B) in close-up on a leaf. (C) Males deposit dozens of spermatophores on floors of pools.



Courtship stimulates a female to position herself over the spermatophore and then pick up the sperm capsule in her cloaca where internal fertilization occurs (Pough et al., 2004). Females of some mole salamander species (e.g., spotted, eastern tiger) lay egg masses that are large and conspicuous (Plate 3-2); others lay single eggs or short strands.

Ambystomatid salamanders are generally long-lived, with some surviving 20 years or longer. Males may be distinguished from females by their enlarged cloacal glands (noticeable bulges under the base of the tail) and more laterally compressed tails. In the breeding season, pregnant females can be identified by their enlarged sausage-like bodies full of eggs.

Larvae develop in water and have wide heads, bushy external gills (three per side), and a long dorsal fin that stretches from behind the head to the end of the tail (Plate 3-2).



Photos: Steven M. Roble

Plate 3-2. Egg mass, larva, and adult salamander. (A) A spotted salamander egg mass, (B) blue-spotted salamander larva, and (C) eastern tiger salamander adult represent the various life stages of species of mole salamanders seasonal pools.

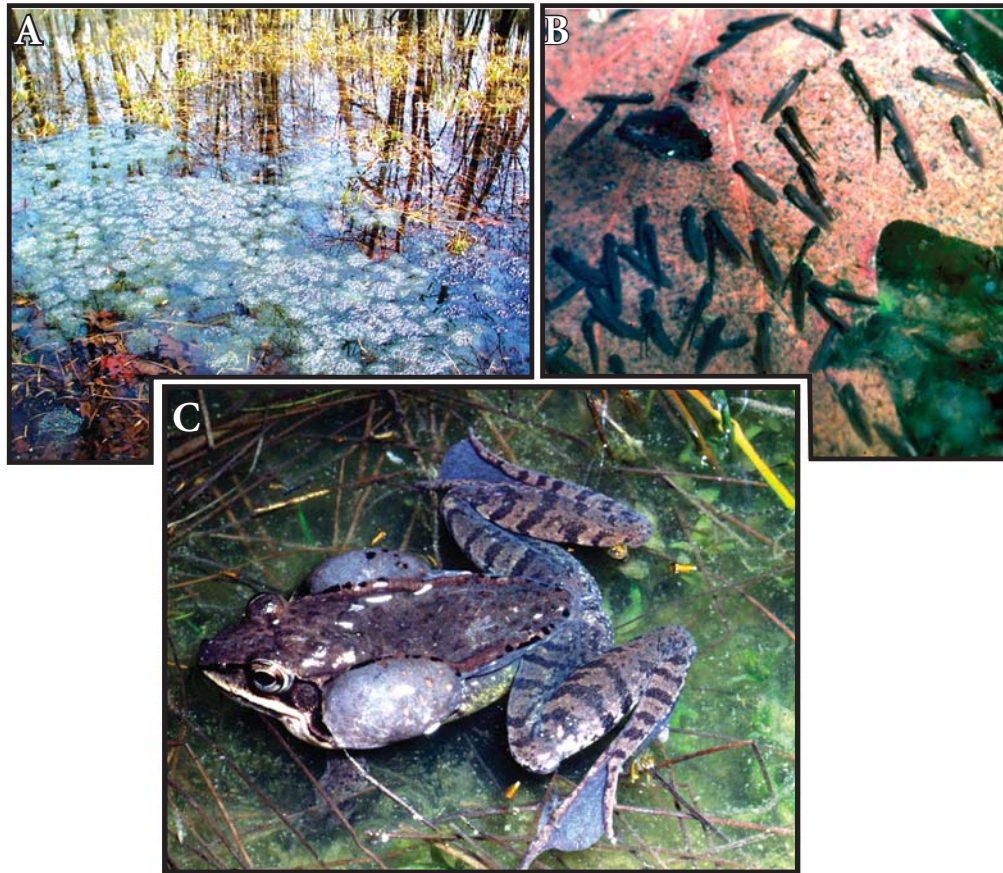
3.4: Frogs and Toads in Seasonal Pools

Frogs are four-limbed, tailless amphibians. Vocalizations, identifiable calls made primarily by adult male frogs, play important roles in frog behavior, including mating and defending territories (Plate 3-3). Seasonal pool-breeding frogs have external fertilization, with males releasing their sperm onto eggs as they are deposited by females. Many male frogs clasp their female partners from behind while mating (a behavior called amplexus) to ensure that their sperm fertilizes the females' eggs. Frog egg masses are less cohesive than the egg masses of most mole salamander species (Plate 3-3).

Eggs laid in the water hatch into aquatic larvae (tadpoles) (Plate 3-3), which are primarily suspension feeders; however, tadpoles of some

species may also feed on smaller-sized larvae or amphibian eggs. Tadpoles undergo a remarkable metamorphosis from herbivorous or omnivorous, aquatic tadpoles to carnivorous, terrestrial adults (Plate 3-3; Pough et al., 2004).

In mid-Atlantic seasonal pools, there are two species of frogs that are indicators: the wood frog (*Rana sylvatica*) and the eastern spadefoot (*Scaphiopus holbrookii*). There are also many other facultative species of frogs and toads that use mid-Atlantic seasonal pools, among them: barking treefrog (*Hyla gratiosa*), gray treefrog (*Hyla versicolor*/*Hyla chrysoscelis*), upland chorus frog (*Pseudacris feriarum feriarum*), and spring peeper (*Pseudacris crucifer crucifer*) (see Field Guide, page 41).



Photos: (A) Tim Maret, (B, C) Steven M. Roble

Plate 3-3. Egg masses, tadpoles, and adult frog. (A) Egg masses, (B) recently-hatched tadpoles, and (C) adult are the various life stages of the wood frog, a seasonal pool indicator species. The adult wood frog pictured is a male making vocalizations.



3.5: Reptiles, Birds, and Mammals in Seasonal Pools

There are many species of reptiles, birds, and mammals in the mid-Atlantic region that feed on prey in or near seasonal pools. Freshwater turtles visit seasonal pools in the spring or summer to feed on algae, terrestrial and aquatic plants, and invertebrates; several species also feed on amphibian eggs, larvae, and adults. Freshwater turtles may be observed in seasonal pools basking out of water on emergent vegetation or logs during warm weather. Spotted turtles (*Clemmys guttata*) inhabit shallow, soft-bottomed freshwater habitats with aquatic vegetation that are in close proximity to woodlands (Plate 3-4). Spotted turtles feed in seasonal pools extensively in the early spring; individuals have been known to spend up to three to four months in seasonal pools (Mitchell, 1994; Milam and Melvin, 2001). Other turtle species that visit seasonal pools in the mid-Atlantic region include eastern snapping

turtles (*Chelydra serpentina serpentina*), eastern mud turtles (*Kinosternon subrubrum subrubrum*), eastern box turtles (*Terrapene carolina*) (Plate 3-4), and painted turtles (*Chrysemys picta*) (Ernst et al., 1994).

Snakes that have aquatic or semi-aquatic life histories may be observed hunting in seasonal pools. More terrestrial snakes may also visit seasonal pools to drink water or to feed, particularly when amphibian larvae are concentrated in shallow pools (J.C. Mitchell, pers. comm.). Snake species that visit seasonal pools to feed primarily on amphibians include, among others, northern watersnakes (*Nerodia sipedon sipedon*), eastern gartersnakes (*Thamnophis sirtalis sirtalis*), and eastern ribbonsnakes (*Thamnophis sauritus*) (Ernst and Barbour, 1989; Mitchell, 1994; Windmiller, 1996).



Photos: Steven M. Roble

Plate 3-4. Turtles of seasonal pools. (A) Eastern box turtles may aestivate in the mud of seasonal pools during hot weather. (B) Spotted turtles visit seasonal pools to feed on invertebrates, amphibian eggs, and other food items.



Birds also prey on animals in or near seasonal pools. Wading birds, such as great blue herons (*Ardea herodias*) (Roble and Stevenson, 1998), waterfowl, such as wood ducks (*Aix sponsa*), and woodland birds visit the pools to feed on insect and amphibian larvae. At coastal plain seasonal pools, yellow legs (*Tringa melanoleuca*, *Tringa flavipes*), little blue herons (*Egretta caerulea*), and green herons (*Butorides virescens*) feed on amphibian larvae (Hassinger et al., 1970). Owls prey on amphibians migrating to and from seasonal pools; birds of prey, such as red-shouldered hawks, feed on seasonal pool animals.

Seasonal pools also serve as important sources of water and food for many mammals in the mid-Atlantic region. Deer drink water and forage on aquatic vegetation in seasonal pools (Plate 3-5). Raccoons feed on amphibian larvae and adults, large insects, and other inhabitants of seasonal pools (Seale, 1982; Kenney and Burne, 2001). Shrews visit seasonal pools to forage on insects (Winfield et al., 1981; Brooks and Doyle, 2001). Bats visit seasonal pools to drink water and to feed on flying insect

prey (Biebighauser, 2002). Scavenging carnivorous mammals are likely to feed on animals trapped, dying, or desiccated in the shallow drying or dried beds of seasonal pools (Winfield et al., 1981), including red fox, striped skunk, gray fox, bear, and opossums.

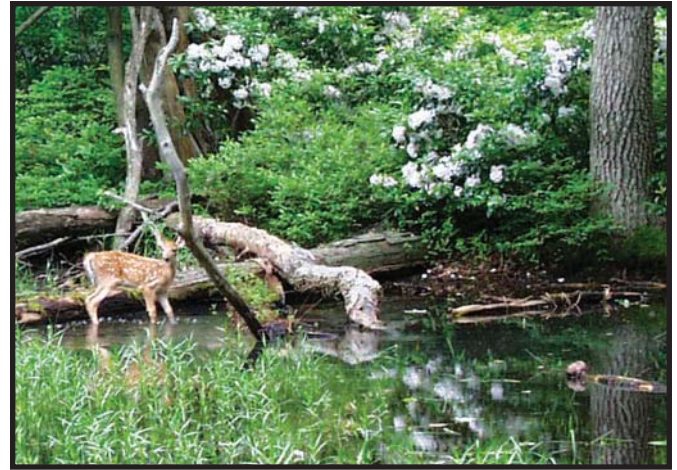


Photo: Tim Maret

Plate 3-5. Deer in an open-canopy seasonal pool. White-tailed deer visit seasonal pools to drink water and to forage on vegetation growing in and around the pool basin.



3.6: Invertebrates in Seasonal Pools

Seasonal pools provide habitat to a wide variety of invertebrate species. Invertebrates in seasonal pools play important ecological roles, as a food source to amphibians and other invertebrates, as consumers of detritus, and as predators of smaller-sized amphibian larvae and invertebrates.

Fairy shrimp, crustaceans in the Order Anostraca, are an indicator group found in mid-Atlantic seasonal pools. Fairy shrimp do not have defenses against predators; therefore, they are very rarely reported in pools with predatory fish and are found in lower abundances in pools with predatory insects. Adults appear in pools in late winter or early spring before predatory insects reach maximum densities (Wiggins et al., 1980). Five species of fairy shrimp may occur in pools in the mid-Atlantic region, although their distribution is not well known (Field Guide; Belk, 1975; Belk et al., 1998). Fairy shrimp glide upside-down and filter-feed microbes and detritus from the water column or substrate (Plate 3-6; Smith, 2001). Fairy shrimp produce eggs that can survive the drying and freezing of pool sediments; they may remain viable for many years before finally hatching. Adult fairy shrimp have patchy

and unpredictable presence and abundance in pools across the landscape. There is very little published research on these animals in the mid-Atlantic region.

In addition to the indicator fairy shrimp, there are numerous facultative invertebrates found in or on the surface of seasonal pools. The more distinctive facultative classes and orders are included in the Field Guide; the following is an incomplete list of classes found in the seasonal pool invertebrate community with the common names of some of their members. Crustaceans include the classes Branchiopoda (clam shrimp and cladocera), Ostracoda (seed shrimp), Malacostraca (isopod and amphipod), and Copepoda (copepod). Molluscs include the classes Gastropoda (amphibious snail) and Pelecypoda (fingernail clam). Arthropods include the classes Insecta (predaceous diving beetle, caddisfly larva, phantom midge larva, chironomid midge larva, and mosquito larva) and Hydrachnidia (water mite). Annelids include the classes Hirudinae (leech) and Oligochaeta (aquatic oligochaete worm).

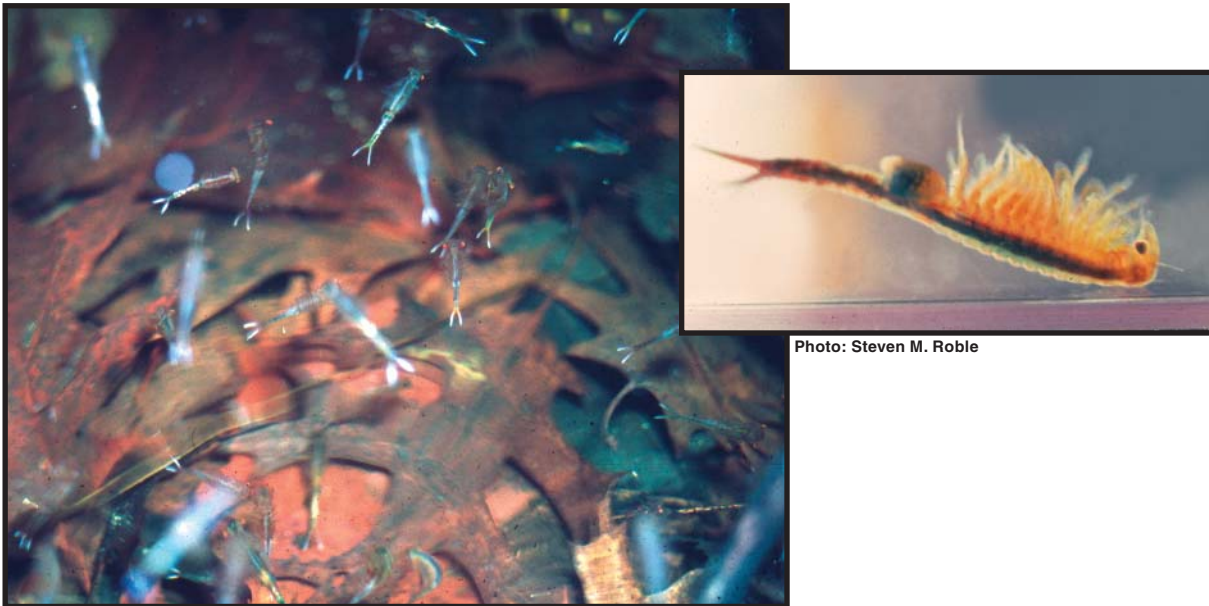


Photo: Steven M. Roble

Plate 3-6. Fairy shrimp in seasonal pools. Seasonal pools may contain the indicator group of crustaceans, the fairy shrimp. In pools where they occur, they may be abundant in the late winter or early spring; notice the eleven pairs of swimming legs.

